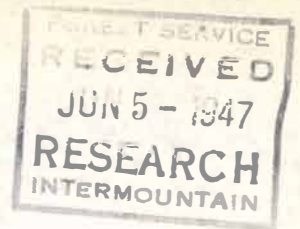


RWE

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
TROPICAL FOREST EXPERIMENT STATION



ADDRESS REPLY TO
DIRECTOR
AND REFER TO



RIO PIEDRAS, PUERTO RICO

R- TR
REPORTS
Annual

January 30, 1947

ANNUAL REPORT AND PROGRAM

TROPICAL FOREST EXPERIMENT STATION

CALENDAR YEAR 1946

TABLE OF CONTENTS

	<u>Page</u>
Factors Shaping Up the Research Program	1
Meeting on Forest Research in the Caribbean	1
Meetings of Forest Service in Washington	3
The Policy Statement and Management Plan	3
The Responsibility of Tropical Forest Research	4
The Research Program. Past and Future	5
Forest Regeneration	5
Silviculture and Mensuration	7
The Experimental Forests	9
Needed Research Not Financed	11
Dendrology	12
Wood Utilization	13
Inter-American Cooperation	13
Station Personnel	14
Project Status Sheets	15
Publications and Papers	27

ANNUAL REPORT AND PROGRAM

Calendar Year 1946

The year 1946 brought a further clarification of the forest research program needed for Puerto Rico and one which would also be applicable in varying degree to tropical forests elsewhere in the Caribbean region. Now, more than ever before, the research staff is dedicated directly and entirely toward those problems^{1/} of most immediate importance.

FACTORS SHAPING UP THE RESEARCH PROGRAM

Several events during the past year have been responsible for the nature and scope of the research of the Tropical Station as the work goes into the new year.

Meeting on Forest Research in the Caribbean

The meeting of the Forestry Sub-committee of the Committee on Agriculture, Nutrition, Fisheries and Forestry of the Caribbean Commission, held in Port of Spain, Trinidad in January 1946, was attended by most of the foresters in the other countries of the Caribbean region and by the Director and Silviculturist from Puerto Rico. All representatives had been requested to and did prepare in advance statements on the status of and need for technical knowledge in each branch of forestry within their respective countries. The group in round table discussion jointly analyzed these statements point by point. There was thus an unprecedented opportunity to see the problems of each country and of the region as a whole. Likewise apparent was the need for more frequent contact between

^{1/} The broad forest problems of Puerto Rico and the general lines of attack through research are discussed in the annual reports of the two previous years.

WEDNESDAY, JUNE 14, 1960

After the meeting, the speaker was escorted to the airport where he was met by a group of friends and family members. He was then driven to his home in a private car.

The speaker was in good health and was able to give a full account of his trip. He was particularly impressed by the hospitality of the people he met and the beauty of the country. He was also very pleased to see his friends and family members.

The speaker was also very pleased to see his friends and family members. He was particularly impressed by the hospitality of the people he met and the beauty of the country. He was also very pleased to see his friends and family members.

THE SPEAKER'S TRIP TO THE UNITED STATES

The speaker was in good health and was able to give a full account of his trip.

The speaker was in good health and was able to give a full account of his trip. He was particularly impressed by the hospitality of the people he met and the beauty of the country.

THE SPEAKER'S TRIP TO THE UNITED STATES

The speaker was in good health and was able to give a full account of his trip. He was particularly impressed by the hospitality of the people he met and the beauty of the country. He was also very pleased to see his friends and family members.

THE SPEAKER'S TRIP TO THE UNITED STATES

THE SPEAKER'S TRIP TO THE UNITED STATES

the respective delegates, for many had done parallel work without knowledge of each other. Further, the bringing together for general use of the information already available within the region, as is planned, will be a great service to all concerned.

Following this analysis of the research information available, the meeting took up the preparation of a program of the important research still needed. Many problems are, of course, local and must be solved within the country concerned. Others, such as physical and mechanical tests of woods and plant identification can best be handled outside the region at established institutions. There remains, however, a large nucleus of problems which (1) are region-wide in scope, (2) cannot be solved within a reasonable time by the individual countries working independently, and (3) should therefore be worked out at a research center maintained jointly by all countries concerned.^{1/}

The charter of the Tropical Forest Experiment Station is sufficiently broad to envelop this "central" research function. So far, however, the Station has not been in a position to perform the functions visualized by the conferees. The size of past allotments to this Station has precluded looking much beyond the many and varied problems of this small island. Where the results of work in Puerto Rico could be of help to others in the region they have been published in The Caribbean Forester. However, even that publication so highly commended by the conferees at Trinidad (and partly supported by the British Colonies) is seriously

^{1/} The findings of the Sub-committee are being published by the Commission in English, Spanish, French, and Dutch under the title of Forest Research in the Caribbean, and copies will be available from the General Secretariat, Caribbean Commission, Queens Park Hotel, Port of Spain, Trinidad.

middle class families who had been in the country for some time.

They were not interested in the country, but in the city.

They were not interested in the country, but in the city.

They were not interested in the country, but in the city.

They were not interested in the country, but in the city.

They were not interested in the country, but in the city.

They were not interested in the country, but in the city.

They were not interested in the country, but in the city.

They were not interested in the country, but in the city.

They were not interested in the country, but in the city.

They were not interested in the country, but in the city.

They were not interested in the country, but in the city.

They were not interested in the country, but in the city.

They were not interested in the country, but in the city.

They were not interested in the country, but in the city.

They were not interested in the country, but in the city.

They were not interested in the country, but in the city.

They were not interested in the country, but in the city.

They were not interested in the country, but in the city.

They were not interested in the country, but in the city.

They were not interested in the country, but in the city.

They were not interested in the country, but in the city.

They were not interested in the country, but in the city.

They were not interested in the country, but in the city.

They were not interested in the country, but in the city.

They were not interested in the country, but in the city.

They were not interested in the country, but in the city.

taxing the resources of the Station from the standpoint of both funds and personnel. Until the Station is better financed, Puerto Rico's local forest problems must continue to absorb the lion's share of the staff's attention.

Meetings of Forest Service in Washington

The discussions at meetings of the Regional Foresters, Station Directors, and Timber Management Chiefs, held in Washington in February 1946, were instructive, constructive and subsequently will be productive of much improvement in forest methodology and technics on all national forests and at all experiment stations. Besides again demonstrating unquestionably that wood is one of the most valuable and necessary raw materials in any country, both in peace and in war, those meetings redefined policies and procedures to meet present-day conditions, provided opportunities for clarification of many problems which had arisen on the Caribbean National Forest as a result of the sharp increase in volume of timber cut and sold in the past few years, and supplied the basis for a critical review of the past research program and the modifications now necessary to assure that first attention would be given to the current major timber management and land use problems and the findings and conclusions thus reached, which are applicable in Puerto Rico, are being incorporated in the programming and the execution of forest research by the Tropical Station and are being adapted and utilized to improve the technical management of the resources of the Caribbean Forest.

Policy Statement and Management Plan

The Caribbean Forest does not yet have the comprehensive policy statement and plan that is needed for sound long-time forest management

in Puerto Rico. In 1943, when timber sales began to increase in number and volume, the need for a cutting budget became immediate. A tentative one was worked out by the research staff. It was soon found, however, that without satisfactory knowledge of the stand, growth, or species characteristics of the forest the project would be one of pioneering. And in the continued absence of the Caribbean's experienced administrative officers in the military service, it was decided by 1944 that the preparation of the first policy statement and plan should become the responsibility of research, rather than administration. Accordingly the collection of the needed basic data was begun. As a consequence research was automatically directed toward the most important administrative problems which in turn will provide the background for a comprehensive timber management problem analysis.

THE RESPONSIBILITY OF TROPICAL FOREST RESEARCH

Despite limitations in personnel and facilities, research must go beyond the Caribbean National Forest in its scope. There is a large field of regional research which should be done. There are the Insular forests, too, with almost twice as much area as the Caribbean Forest. Then, there is the Agricultural Extension Service with programs under both Section 4 and Section 5 of the Clarke-McNary Act. Thus it is not easy to set priorities, and in practice almost all of the current investigations are directed toward assistance to more than one of these agencies and the results are generally of some benefit to all four.

THE RESEARCH PROGRAM, PAST AND FUTURE

The research program of the Tropical Station has gone through several more or less well marked developmental stages in the past.

Forest Regeneration

One of the primary reasons for the establishment of the Station was the need for a study of the plantings being done by CCC in the Caribbean, Insular and PRRA forests. Large scale projects were not giving satisfactory results. A complex group of factors were involved, the action of which was not understood. This circumstance led to the dedication of virtually all research personnel to regeneration problems, seed, nursery, and planting studies. This situation persisted for at least 6 years, or until the beginning of 1946.

Within the regeneration investigative program emphasis and methods have changed considerably during the past 6 years. In retrospect these changes appear to have been due largely to the fact that the relative importance of different problems has been coming to light gradually. To a certain degree the staff has been too busy with the trees to see the forest.

At first a number of short studies of different phases of regeneration of various species were carried out. Emphasis was on methods of propagation and planting methods. None of this work is considered wasted, for nursery practice was certainly in need of improvement at that time, and seed storage was also a problem. However, it now seems unfortunate that such a small portion of the time available was spent on the study of site adaptability in the field where the most important losses were being suffered.

In 1943 the pendulum started to swing in the other direction. With such a large number of promising species to consider, simple exploratory

EXHIBIT QUA 104, WISCONSIN POLICE DEPT

through door and windowed balcony and to various places and

used with the search for the following items: 1. A small box

Police Department

located and to immediately and to various places and to the

and at 1000 yd and used with the search for the following items:

from the following items: 1. A small box

located with the search for the following items: 1. A small box

and at 1000 yd and used with the search for the following items:

located with the search for the following items: 1. A small box

from the following items: 1. A small box

located with the search for the following items: 1. A small box

about an hour and a half and used with the search for the following items:

used with the search for the following items: 1. A small box

located with the search for the following items: 1. A small box

from the following items: 1. A small box

located with the search for the following items: 1. A small box

located with the search for the following items: 1. A small box

about an hour and a half and used with the search for the following items:

used with the search for the following items: 1. A small box

located with the search for the following items: 1. A small box

from the following items: 1. A small box

located with the search for the following items: 1. A small box

about an hour and a half and used with the search for the following items:

used with the search for the following items: 1. A small box

located with the search for the following items: 1. A small box

from the following items: 1. A small box

located with the search for the following items: 1. A small box

studies were started. They were at that preliminary stage where what was not obviously successful deserved no further attention until other species had been tried. If, as a result of exploratory tests, a species looked promising, a more comprehensive study was set up.

These exploratory studies have been made with about 170 species. Depending upon the importance of the species, they have included some or all of such phases as seed cleaning, storage, germination, shade and growth in the nursery, watering, spacing, stock size, transplanting, ground preparation in the field, planting, underplanting, weeding, and subsequent site adaptability. An effort has been made to include all native species of promise, as most of these had been neglected previously for more spectacular exotics.

Exploratory regeneration studies occupied nearly all of the time of the research staff in 1944 and 1945, and much time was devoted to them in 1946 as well. The fund of information accumulated has helped to avoid past mistakes in the more recent planting program which often resulted from enthusiasm for a certain species based on the development of an individual tree or small planting, often on a non-forest soil, or based solely upon reports in the literature regarding results elsewhere. Now, however, it appears that the emphasis on this phase of regeneration research should be reduced for the following reasons:

1. What appear to be the most promising species have already been tested.
2. More comprehensive study of some of the better species found seems of higher priority than continued exploration.
3. Little is known about the wood of the native species not yet

tested and nothing is known of their growth. Ease of regeneration plus merchantable size and good form at maturity cannot alone supply a basis for appraisal of a species.

New species must always receive attention in the program, but it should be secondary to species with an established reputation.

The study of site adaptability was considerably intensified in 1945 when a detailed survey of all plantations in the Federal and Insular Forests was undertaken (78 plantations including about 35 species, on 20,000 acres). Complete results are not yet available, but they include planting site classifications for each forest and a discussion of survival and growth of each species on each site. The findings will be of such direct value in planning planting programs that it is now realized that this should have been one of the first jobs of the Station.

During the coming year regeneration research will center on the completion of the plantation surveys, further tests of site adaptability of promising species, and the study of soil maintenance problems which have recently come up in a large nursery which supplies stock for planting both public and private lands.

Silviculture and Mensuration

Studies of silviculture and mensuration occupied a minor place in the research program until recently. Work included the establishment of small growth plots and a few measurements in the relatively rare but more easily studied pure forests of Puerto Rico.

Silvical and mensuration studies superseded regeneration as the most important phase of the research program during 1946 for the following reasons:

1. The future problems on the public forests of Puerto Rico will be increasingly a matter of treatment of existing stands rather than reforestation.
2. Preliminary studies indicate that silvicultural treatment can accelerate tree growth in Puerto Rico from the rate of the hardwoods of the Lake States (growth rate of undisturbed forest here) to that of the most rapid growing hardwoods of the south.
3. Studies of silviculture and mensuration are essentially long-time in nature and must be started promptly for early results (no annual growth rings).
4. The need for all available forest products in Puerto Rico is greater than ever, a need which can be supplied on a permanent basis only with yield controls based upon such research. Almost no reliable information on increment and yields is yet available.
5. Regeneration research is farther advanced than silvicultural research. Productive tree species (although possibly not the ultimate best) well adapted to all sites are known as are generally satisfactory methods of propagation and establishment.
6. Studies of plantation care (silviculture) and growth (mensuration) are needed before the real success of regeneration efforts can be appraised.

Investigations in these fields to date have been concentrated on the individual tree rather than on the stand as a whole. Natural forests are so mixed and heterogeneous, and sites are so variable within short distances in the local dissected erosion topography, that sampling of stands, if to be adequate for general application, must approach 100%. Much the same

the first part of the year, the weather was very warm and the
second part of the year, the weather was very cold and the
third part of the year, the weather was very wet and the
fourth part of the year, the weather was very dry and the
fifth part of the year, the weather was very windy and the
sixth part of the year, the weather was very calm and the
seventh part of the year, the weather was very stormy and the
eighth part of the year, the weather was very sunny and the
ninth part of the year, the weather was very cloudy and the
tenth part of the year, the weather was very clear and the
eleventh part of the year, the weather was very foggy and the
twelfth part of the year, the weather was very bright and the
thirteenth part of the year, the weather was very dark and the
fourteenth part of the year, the weather was very light and the
fifteenth part of the year, the weather was very heavy and the
sixteenth part of the year, the weather was very thin and the
seventeenth part of the year, the weather was very thick and the
eighteenth part of the year, the weather was very smooth and the
nineteenth part of the year, the weather was very rough and the
twentieth part of the year, the weather was very soft and the
twenty-first part of the year, the weather was very hard and the
twenty-second part of the year, the weather was very loose and the
twenty-third part of the year, the weather was very tight and the
twenty-fourth part of the year, the weather was very wet and the
twenty-fifth part of the year, the weather was very dry and the
twenty-sixth part of the year, the weather was very warm and the
twenty-seventh part of the year, the weather was very cold and the
twenty-eighth part of the year, the weather was very hot and the
twenty-ninth part of the year, the weather was very cool and the
thirtieth part of the year, the weather was very warm and the

result may be achieved through detailed study of the silvical characteristics of each species, growth rates, etc., followed by a synthesis of this information for any specific stand composition and structure. Growth rates of trees in different crown classes, reproduction, maximum size, form, and diseases are being studied for each species.

The development of improvement cutting practices is being approached in two ways: (1) the detailed study of the growth of individual trees as related to micro-environmental factors, and (2) the relationship between stand basal area and growth. In the absence of annual growth rings, studies of this type require at least 5 years for completion. It is believed that the first type of study can provide information as to the degree to which trees must be released to maintain good growth and will show the shade density necessary to control weeds and vines. Basal area studies will translate this information into terms of area.

Silviculture and mensuration are here grouped because both subjects are involved in the same studies. At this preliminary stage, there are so many factors to consider that studies have been begun in the natural undisturbed forest. The results of these studies will serve as a basis for more advanced investigations of various treatments at a later date.

The Experimental Forests

With the research organization combined in the Tropical Forestry Unit with the administration of the Caribbean and Insular Forests it has not been necessary to set aside specific areas within the public forests solely for research. Any reasonable need for an area for experimentation within these lands has always been satisfied. However, experimental forests have been established outside the public forests, with two general purposes in mind:

(1) Provision for research on extensive forest sites not included within the public forests and where farm or community forestry must be developed, and (2) Provision for forest areas nearer headquarters than the public forests, where closer control over experiments can be maintained.

Three experimental forests, St. Just, Rio Piedras, and Cambalache, continued in use during 1946. The highlights of progress not given in the project status sheets are here described.

St. Just

The St. Just forest (29 acres) has continued as an important proving ground for new species on sites suitable for farm forestry. Species which have come into prominence for farm forestry as a result of studies made here are Lonchocarpus latifolius, Casuarina lepidophloia, and Albizzia moluccana. Improvement cuttings made during the year in seven acres yielded 14 cords of fuelwood given free to 21 nearby families.

Rio Piedras

The Rio Piedras woodlot (9 acres), located on the coastal plain less than 1/2 mile from Headquarters, is particularly well suited to studies of underplanting and growth. A young mixed stand in this forest grew from 60 to 76 square feet of basal area in 3 years. The average annual diameter growth of the dominant trees was 0.82", and for all trees, 0.37". This is much more rapid growth than has been found in the mountains.

Cambalache

The Cambalache Experimental Forest (616 acres) has served not only as an area for planting and silvicultural research but has shown clearly the local value of forests in the more densely populated rural areas of Puerto Rico. This forest was cited in the Governor's report to the 1946 Legislature

confronted with the fact that the Government has not yet been able to secure the necessary funds to carry out its policy of economic development. The Government has not yet been able to secure the necessary funds to carry out its policy of economic development.

Conclusion

The Government has not yet been able to secure the necessary funds to carry out its policy of economic development. The Government has not yet been able to secure the necessary funds to carry out its policy of economic development.

References

The Government has not yet been able to secure the necessary funds to carry out its policy of economic development. The Government has not yet been able to secure the necessary funds to carry out its policy of economic development.

Appendix

The Government has not yet been able to secure the necessary funds to carry out its policy of economic development. The Government has not yet been able to secure the necessary funds to carry out its policy of economic development.

as an outstanding example of inter-bureau cooperation, i.e., Land, P.R. Land Authority; Management, Forest Service; Soil conservation in farm areas and along road, Soil Conservation Service; and Construction of improvements, Insular War Emergency Program.

Studies of this forest led to recommendations which have this year begun action toward the proper management of the forest lands now held by the Land Authority. It is expected that by the end of the fiscal year the protection and management of several thousand acres of forest (perhaps more properly woodland) will be transferred from the Land Authority to the Insular Forest Service.

The year's work at Cambalache has shown clearly the need for intensive follow up after underplanting. Trees planted beneath the natural stands with the expectancy that they can take care of themselves will generally fail soon after planting (1) if in the shade, because of lack of timely release, or (2) if in an opening, because of competition from weeds and vines.

Improvement cutting shows promising early results. Where adequate shade was left vines have not recovered after cutting. The yield from the first improvement cutting in a young forest at Cambalache has nearly repaid all costs. Sixty-six timber sales were made, including 3,307 posts and poles and 46 cords of fuelwood. Cash receipts totalled \$455.09. Besides that, a total of 117 nearby families removed 3,830 bundles of dead fuelwood, equivalent to 74 cords, during the past year.

OTHER RESEARCH NEEDED BUT NOT FINANCED

Investigations of regeneration, silviculture, and mensuration have always needed the full attention of the Station's research personnel.

...the

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

However, numerous projects which, at least at time, are considered of immediate importance, are continually coming up. Submission to the temptation to undertake such projects has in the past resulted in spreading efforts too thinly. Two clearcut examples of such projects are dendrology and wood utilization.

Dendrology

There are more than 500 native arborescent species in Puerto Rico and a greater number of exotics. To the untrained eye these trees are much more alike than in the States. The bark of all species is almost invariably smooth and of the same general color, and the leaves are generally ovate, entire, and of about the same size. Thus, particularly to an outsider who has not seen the trees before (only about 1% are native to the U.S.), the problem of tree identification is a formidable barrier to research. Only a handful of Puerto Ricans know the trees at all well.

It was natural, therefore, that one of the first projects on the establishment of the Station in 1940 was the simplification of tree identification. Two volumes on the trees of Puerto Rico were published and work was started on a simple key to species. A herbarium was also begun. Preliminary forest type distinctions were made. This work has done much to facilitate later research, yet if continued on a desirable scale it would call heavily upon the time of the small staff, time which appears to be more needed for other projects.

About a year ago dendrological and ecological work was discontinued. Further progress must await funds for the addition of an ecologist or taxonomist to the staff.

Wood Utilization

The need for more information on the properties of the wood of the local species is manifest. It is impossible to appraise tree species whose wood utility is unknown. Some of the exploratory regeneration tests have been made with species which merely "look good", in the hope that wood studies would soon follow. Species appraisal is of utmost importance in marking policies for stand improvement, a project which cannot be put off indefinitely.

In the belief that short tests of durability, specific gravity, moisture contents, and drying would not overtax the staff, a certain amount of this type of work has been done. A wood sample collection was started. It was soon recognized, however, that study of even those rather superficial wood characteristics required a full-time wood technician. Work in this field has been discontinued and cannot be again taken up by the present staff.

INTER-AMERICAN COOPERATION

The Tropical Forestry Unit upon its establishment in 1943 was designed to have three major functions federally, namely, forest research through the Tropical Station, forest administration of the Caribbean National Forest, and forestry cooperation on an inter-American basis. Wartime restrictions prevented the Unit from discharging its responsibilities in the third field, at least prior to 1945, although it did act administratively with respect to some of the Forest Service parties in South America.

The technical journal, The Caribbean Forester, has been published each quarter since 1940, and through financial cooperation in part from the British Colonial Governments, it was increased both in size and circulation, beginning in 1945. Part I of a comprehensive paper of 600 pages on the

Forest Types of the Caribbean Islands, prepared by Henry Stehlé, Chief Forester of Martinique, was published in English, Spanish, and French, as a supplement to The Caribbean Forester in 1946; and Part II will appear in the three languages in 1947.

Not reported in last year's report were the contacts made by the Assistant Chief of the Forest Service for Research and the Director among the technical foresters from many of the republics of Central and South America at the Third Inter-American Conference on Agriculture at Caracas, Venezuela, in August 1945. The meeting of technical foresters from Cuba, Puerto Rico and all of the British, French, and Netherland colonies in the West Indies, under the auspices of the Caribbean Commission, was held at Port of Spain, Trinidad, in January 1946 as already mentioned. A call is pending for an early visit by a member of the Station staff to the Inter-American Institute of Agricultural Sciences in Costa Rica for advice on forest administration, research, and education. Correspondence with foresters in the American tropics is on the increase.

All of this, however, does not meet the inter-American program visualized in the beginning nor can progress to that end be made unless and until this major responsibility is adequately supported financially and perhaps not until an amendment of the McNary-McSweeney Act to permit engaging in forest research outside the United States and its possessions.

STATION PERSONNEL

José Marrero, Forester P-2, who was granted leave of absence, beginning in June 1945, to attend the Forest School at the University of Michigan returned to active duty in October 1946, having completed the requirements for a Master's degree in Forestry which is in addition to the Bachelor's degree he had held in Agronomy. Mr. Marrero will again be assigned to and actively prosecute studies in artificial regeneration.

Frank H. Wadsworth, Forester P-4, and acting in charge of the Station's research program, has been granted leave of absence to begin work on a Doctor's degree in Forestry at the Forest School of the University of Michigan, beginning in January 1947. He will return to the Station for duty

from June through September and will then be absent until early in 1948. During his absence Mr. Marrero will be acting in charge of the research work.

Mr. Raúl Ybarra Coronado, Subdivision Assistant on the Caribbean Forest, was transferred in June 1946 to the research staff as Agricultural Aide, SP-4. Following prescribed standards and methods of work he will continue the timber inventory and sample plot work on the Caribbean Forest.

Miss Zhura Caballero Anselmi, Laboratory Helper SP-1, will leave early in 1947 to take a two-term course in statistics and supporting subjects at American University in Washington, and will return to the Station by December 1947.

There were no separations from the research staff during the year and the personnel as of January 1, 1947 is as follows:

Arthur T. Upson*	Director of Tropical Forestry (also Chief, Insular Forest Service)
Ana T. Vega de Jiménez*	Clerk-Stenographer
L. V. Heljeson*	Administrative Asst. & Fiscal Agent
Angel L. Ferrer*	Clerk
Frank H. Wadsworth	Silviculturist
José Marrero	Forester
Carmen García-Piquera Ruiz	Translator
Luz Silva	Stenographer
Raúl Ybarra Coronado	Agricultural Aid
Zhura R. Caballero Anselmi	Laboratory Helper
Antonio Cruz Soto	Skilled Laborer
Bernardo Lozada	Unskilled Laborer

Collaborators

Luis Enrique Gregory	Taxonomist, Puerto Rico
Leslie R. Holdridge	University of Michigan
Luis F. Martorell	E Entomologist, Puerto Rico

* Assigned to Tropical Forestry Unit; time divided between Tropical Forest Experiment Station and Caribbean National Forest

PROJECT STATUS SHEETS

This annual report and program has to this point intended to be a running account of forest research in Puerto Rico, its scope at the start, how it developed over the seven years of its life, what now needs the most emphasis and what does not, and the factors shaping up the program as it goes into 1947. The research results of previous years and in 1946 have been reserved for the detailed status sheets project by project which immediately follow and with some also to be found in the publications and papers which are next listed. (Note: The project "Farm Woodlands" described in last year's report has been dropped as such and its several phases merged into three of the other projects.)

STAND IMPROVEMENT

Field Division: Forest Management Research

Work Project: Silviculture

Line Project: Stand Improvement

Purpose: To develop practical methods for improving forest growth and quality by pruning, thinning, and other cultural treatment.

Review of Past Work: Cutting of all subordinate trees of 0.5 to 2.0" d.b.h. in young mangrove to supply small stakes proved unsatisfactory silviculturally because it failed to remove large misshapen trees or to accelerate materially growth rate of remaining dominants. In lower montane rain forest approximately 60 percent shade controls vines and weeds yet permits the more tolerant reproduction to develop. Cutting should be confined to stands denser than this and should remove inferior trees to that point. A 20-year-old plantation of Calophyllum calaba, thinned from 165 to 101 square feet of basal area per acre, yielded poles and fuelwood worth \$285.00 per acre. Young mangrove thinned to basal area of 38 sq. ft. per acre had attained 97 sq. ft. seven years later. Eighty-two common forest trees were appraised as regards growth, form, and utility for use in marking timber.

Accomplishments during Past Year: Thinning of the 20-year old stand of Calophyllum calaba (See above) accelerated the annual average diameter growth of the residual trees from 0.21 to 0.30 inch the first year after thinning. These represent the first such data collected in Puerto Rico for any species. An experimental improvement cutting in six acres of young forest within the Cambalache Experimental Forest removed 2,575 trees of from 2 to 14 inches diameter. The cutting cost \$100.00 and yielded 16 1/2 cords of fuelwood and 66 poles which brought \$86.53. The second cut, 5 years later, should pay its way. A 0.075% solution of 2,4-D was found capable of killing vine growth on young trees. The Alemite spray gun was tested for timber marking, using a solution of 50% red lead and 50% kerosene, with highly successful results, even during wet weather. Approximately 50% of marking time was saved.

Plans for Next Year: Begin formal study of stand improvement in the natural forest of the Luquillo Mountains. Second remeasurement of Calophyllum thinning plots. Further tests of 2,4-D in vine control to reduce difficulties in transporting solution and in treating tall trees covered with vines.

Date of Completion: Continuing

Assignment: Wadsworth

SILVICS

Field Division: Forest Management Research

Work Project: Silviculture

Line Project: Silvics- Environmental Factors

Purpose: To determine silvical characteristics of valuable tree species as a basis for silviculture.

Review of Past Work: Growth records have been started in 21 stands of distinct composition and structure, including nearly 100 species. In the lower montane rain forest two-year diameter growth of 940 trees was found to average 0.30". The dominants grow 0.52"; the codominants 90% as rapidly; the intermediates, 60%; and suppressed trees 27%. Eighty-two percent of the trees were intermediate or suppressed. Among the dominant trees the intolerant species were growing only slightly more rapidly than the tolerant species. Among the suppressed, the superiority of the tolerant trees over the intolerants was more marked. Underplanted trees, however tolerant, do not make rapid growth unless located beneath openings of 4 to 12 feet in diameter (depending upon canopy height). Current annual diameter growth in a 20-year-old plantation of Calophyllum calaba on a very poor site was found to be 0.4" for dominants, 0.3" for codominants, and 0.2" for intermediates. The growth rate of 65 trees of Bucida buceras in the dry limestone forests at Guanica proved disappointingly slow, 0.14 inch in diameter annually. Dominant trees averaged 0.23 inch.

Accomplishments During Past Year: Remeasurement in the lower montane rain forest after 3 years and in the Calophyllum plots at the end of the second year corroborated earlier findings as described above. Thirteen additional permanent silvical growth plots were established in three new types on four sites with more than 10,000 trees. Species, diameter height, and crown and vigor classes were recorded. Preliminary analyses are in progress. Reproduction plots, now 10 years old, showed that excessive opening of the forest does not greatly accelerate the growth of shade-tolerant species. As a result the intolerant species, even reproduction established after the cutting, may overtake and redominate the more desirable species.

Plans for Next Year: Complete measurements for determination of height growth in Sierra Palm plots. Establish silvical plot in the Cambalache Experimental Forest. Remeasure all plots established to date.

Date of Completion: Continuing

Assignment: Wadsworth

PLANTING STUDIES

Field Division: Forest Management Research

Work Project: Regeneration

Line Project: Planting

Purpose: To develop improved planting methods, and to determine proper spacings, adaptability of species to site, and relative merits of planting of nursery or wilding stock vs. direct seeding.

Review of Past Work: Preliminary studies of planting methods and site adaptability have been made with 126 species. Swietenia macrophylla stock, kept moist, may be held 16 days between lifting and planting without reducing survival. Several other species may be held 8 days. Tabebuia pallida, Guarea trichilioides, and Cordia alliodora may be readily established with wildings, which, if well rooted, give higher survival than nursery stock. Bucida buceras can be successfully planted with a ball of earth (tar paper pots). Swietenia mahagoni and Stahlia monosperma have given high survival direct seeded under partial shade in the limestone region. Prunus occidentalis plants successfully bare-rooted at 2000 feet elevation in the Luquillo Mountains.

Accomplishments during Past Year: Survey of all plantations within the Caribbean National Forest was completed; on Insular forests 90% completed. Planted species considered promising in the Luquillo Division are: (1) valleys and extreme lower slopes, Cordia alliodora, Manilkara nitida, Lucuma multiflora, Ocotea moschata, and Swietenia macrophylla; (2) on middle half of the slopes, Cordia alliodora, Manilkara nitida, Lucuma multiflora, Petitia domingensis, Calophyllum calaba, Tabebuia pallida, and Byrsonima spicata; (3) on ridges and extreme upper slopes, Calophyllum calaba and Tabebuia pallida. In the Toro Negro Division successful species are Montezuma speciosissima, Guarea trichilioides, Cordia alliodora and Eucalyptus spp. Planting tests were made with five new species. Plantings of bamboo in both Luquillo and Toro Negro Divisions show high early survival. Planting, underplanting, and plantation maintenance policies were developed for the Caribbean Forest.

Plans for Next Year: Finish survey of plantations of Insular Forests. Prepare and publish results. Test 62 new varieties of eucalyptus and hybrid pines recently received and Pinus rigida var. serotina. If time permits commence survey of plantations on private lands to determine growth and site adaptability of different species.

Date of Completion: Continuing

Assignment: Marrero, Wadsworth

NURSERY STUDIES

Field Division: Forest Management Research

Work Project: Regeneration

Line Project: Nursery Studies

Purpose: To develop methods for economical production of planting stock with capacity for high survival in the field.

Review of Past Work: Preliminary studies of propagation of 102 native and exotic species have been made. Optimum spacing for Eucalyptus robusta was found to be 6" x 6"; for Casuarina equisetifolia, 1" x 6"; and for most other species, 3" x 6". Root system of Casuarina equisetifolia is materially improved by transplanting, which should be done when seedlings are 8 to 10 inches tall. Daoryodes excelsa is difficult to propagate at sea level, but does well at 2,500 feet. Seeds of Manilkara nitida should be sown in moist leaves as they are not sufficiently strong to push up through soil. Discontinuation of watering of Sciacassia siamea stock one month prior to lifting caused marked "hardening" of stock and higher field survival. Stock growth records from all forest nurseries from 1924 to 1934 have been summarized (48 species, 3,159 sowings). Almost no tree species prefer direct sunlight to partial shade during germination and the first month. Thereafter full sunlight generally produces more vigorous stock. Crotalaria striata is fairly satisfactory nursery cover crop, providing a good cover and an abundance of organic matter in a short time.

Accomplishments During Past Year: Bay bean, Canavali maritima, is less satisfactory as a cover crop than is Crotalaria as it does not rapidly cover the ground or produce as large a volume of organic matter. A solution of 0.075% 2,4-D killed weeds effectively (not grasses) in nursery beds without damage to Eucalyptus robusta, but even 0.0375% was fatal to Casuarina equisetifolia.

Plans for Next Year: Develop satisfactory soil maintenance program at La Catalina nursery, including use of cover crops, compost, liming, and mineral fertilizers. Determine optimum size for transplanting of Eucalyptus. Continue tests of herbicides to determine frequency of treatment needed. Determine adaptability of an all metal transplant board to our needs. Explore use of DDT in control of mole crickets.

Date of Completion: Continuing

Assignment: Marrero

SEED STUDIES

Field Division: Forest Management Research

Work Project: Regeneration

Line Project: Seed Studies

Purpose: To develop satisfactory methods of collection, extraction, storage and testing of seed to meet nursery and direct seeding requirements.

Review of Past Work: Studies of germination and storage have been conducted with 155 native and exotic species. Concentrated sulfuric acid scarification of Sciacassia siamea for 10 minutes shortened germination period from 60 to 10 days. Viability of seed of Swietenia macrophylla and Cedrela mexicana can be increased from 3 to 9 months by storage at 40°F. Seed viability of Cordia alliodora can be increased from 4 weeks to 3 months by desiccating to 25% of fresh moisture content and sealed storage at 40°F. Viability of seed of Montezuma speciosissima increased from 2 weeks to 2 months by storage at 40°F when dried to 62% of natural moisture content. Seed of Manilkara nitida and Lucuma multiflora remains viable only one month at room temperature. Low germination in Bucida buceras is due to incomplete seed formation and insect attack. Seeds of Guaiacum officinale are not mature until they turn orange, and cold storage is detrimental to retention of viability. Nursery records since 1924 on rapidity of germination of 294 native and exotic species in 11,584 sowings were summarized.

Accomplishments during Past Year: Fourteen new species were weighed and germination tested.

Plans for Next Year: Study relationships between seed quality and parent tree in Bucida buceras, Magnolia splendens, M. portoricensis, and Hyeronima clusioides. Routine germination and weighing tests of available seeds of promising species not already tested.

Date of Completion: Continuing

Assignment: Marrero

TREE STUDIES

Field Division: Forest Management Research

Work Project: Mensuration

Line Project: Tree Studies

Purpose: To develop practical methods for rapid, accurate measurement of tree volume before and after cutting.

Review of Past Work: Board foot converting factors were developed for stakes, posts, poles, crossties and oxyokes. Form factor volume tables were prepared for Puerto Rican hardwoods by J. W. Girard.

Accomplishments during Past Year: Ocular estimation of cubic volumes (converted by Smalian's formula) of more than 3000 trees has been made as a preliminary to the preparation of cubic foot and cordwood volume tables. Diameter-height data from 1937 cruise of Caribbean analyzed by species. Little variation found between species.

Plans for Next Year: Check ocular estimates of volumes by direct measurement and estimate volumes of additional 6,000 trees in permanent plots. Check cordwood-charcoal conversion factor.

Date of Completion: Indefinite

Assignment: Wadsworth

STAND STUDIES

Field Division: Forest Management Research

Work Project: Mensuration

Line Project: Stand Studies

Purpose: To determine the growth, mortality, and yield of important forest types.

Review of Past Work: Yield from 8-year-old mangrove forest, out to 3" diameter limit, was 3,452 posts of 2" to 3" top diameter and 10 cords of fuelwood, total stumpage value \$183.00 per acre, or \$23 per acre per year. Yield from 10-year-old plantation of Casuarina equisetifolia averaged 3.12 cords per acre per year. On favorable sites this species attains diameter of 9.5" in 10 years and 15" after 20 years. Coppice stands of Eugenia jambos when clear cut yielded 20 to 25 cords per acre on an 8-year rotation, or 2.5 to 3 cords per acre per year. Thirty-acre plot established in Cambalache Experimental Forest to provide, with other information, data on natural mortality.

Accomplishments During Past Year: Thirteen permanent growth plots (also referred to under "Silvics") were established in Luquillo mountains, containing over 10,000 trees. While primarily for silvical research they will serve also to provide information on growth, mortality, and yield. Eucalyptus robusta trees of from 10 to 18 inches in diameter were found to be still growing rapidly on a very adverse site, indicating that the extensive area being planted to this species can produce large trees at an early date.

Plans for Next Year: Remeasurement of mangrove plots to strengthen growth data. Establish small growth and yield plots in plantations of Tectona grandis, Swietenia macrophylla, and Montezuma speciosissima at Rio Abajo; Swietenia mahagoni at Guajataca; Cedrela mexicana at Luquillo; and Cordia alliodora at Carite.

Date of Completion: Continuing

Assignment: Wadsworth

INVENTORY, YIELD, REQUIREMENTS

Field Division: Forest Survey

Work Project: Survey of Forest Resources, Present and Future requirements.

Line Project: Inventory, Yield, Requirements

Purpose: To collect and interpret data on stands, growth, yield, mortality, and requirements as a basis for preparation of plans of sustained yield management by Federal Forest Service for Caribbean National Forest, and by Insular Forest Service for Insular Forests

Review of Past Work: Working circles were established in Caribbean Forest based upon desirability of providing permanent employment within walking distance of homes of forest workers. Minimum stumpage rates and marking rules were drawn up. Tentative cutting budget for Caribbean was prepared, based upon timber survey data.

Accomplishment During Past Year: The 1937 timber survey data were studied and found satisfactory for use in Colorado type where growth is relatively slow. They are being reanalyzed by compartments to determine composition and density of this type. Detailed study of volume, growth, and reproduction is being made for each type and site in the 13 plots referred to under "Silvics". Large scale contour maps and base maps were drafted from new quadrangle sheets. Type lines, open areas, and probable limit of forest land (decided largely by slope) were determined from aerial photographs and checked from the air at low altitude. Virtually all literature (more than 800 references) which might be related to management problems of Caribbean has been summarized for use. The Insular Forest Service, under a new project authorized and financed by the 1946 Legislature, began an inventory of the forest resources of Puerto Rico. The 1947 Legislature is expected to finance the continuance of the project with completion scheduled for sometime in 1948. The quadrangle sheets for Puerto Rico, editions of 1945 and 1946, of the Geological Survey, which are based on recent aerial photography and plane-table work and which show in color the limits of all brush and timbered lands are being used, thus eliminating the need of extensive ground control, with each such area to be sampled by plot or strip method for stand composition, quantity and quality.

Plans for Next Year: Complete policy statement for Luquillo Division. Inventory tabonuco type. Analyze plot data on composition, growth, and volume.

Date of Completion: Luquillo Management plan early 1948, Toro Negro in 1948, Insular forests thereafter.

Assignment: Wadsworth:

INTER-AMERICAN COOPERATION

Field Division: Forest Management Research

Work Project: General

Line Project: Inter-American Cooperation

Purpose: To advance forestry in the tropics of the Western Hemisphere through assistance and cooperation in common regional problems.

Review of Past Work: The Caribbean Forester, an eighty-page trilingual journal, published and distributed since 1939 to a mailing list of more than 600. Forestry Sub-committee set up in 1944 within Caribbean Research Council of Anglo-American Caribbean Commission with Tropical Station, holding membership. Memorandum of Understanding consummated in 1944 between B.W.I. and Station under which former colonies now making token contributions for enlarged editions of Caribbean Forester. Surveys of forest resources were conducted in Costa Rica, Ecuador, and Chile. All English terms and 370 Spanish terms found and defined for a Spanish-English glossary of forestry terminology.

Accomplishments During Past Year: Director presided at meeting of Forestry Sub-Committee at Port of Spain, attended by representatives from Trinidad, Windward and Leeward Islands, British Guiana, British Honduras, Jamaica, Cuba, Martinique and Guadeloupe, Surinam and Puerto Rico. Based on material prepared and distributed in advance, meeting discussed and appraised results of tropical forest research to date and prepared program of needed future research classified whether to be done locally, regionally, or extraregionally. Recommended to Commission establishment of a Forest Research Center within Caribbean Area. Caribbean Forester published, with articles from Ecuador, Venezuela, Cuba, Peru, Guadeloupe, and Puerto Rico. First section of glossary published, with 100 terms in English and Spanish.

Plans for Next Year: Publication of 100 more terms of the glossary. Continue publication of The Caribbean Forester. Report and recommendations of Forestry Subcommittee to be published and widely distributed by Caribbean Commission in 1947.

Date of Completion: Glossary, indefinite; balance of project continuous.

Assignment: Upson, García-Piquera, Wadsworth

DENDROLOGY

Field Division: Forest Management Research

Work Project: Silviculture

Line Project: Silvics- Tree Distribution, Dendrological Studies.

Purpose: To identify and to facilitate identification of trees of Caribbean region; to standardize common and scientific nomenclature; and to determine and to describe natural distribution of forest associations of the region.

Review of Past Work: Herbarium of about 2,000 specimens has been accumulated. Ink drawings of specimens of 325 trees have been prepared and 100 of these were published with descriptions in English and Spanish. Approximate original location of 7 primary forest types of Puerto Rico has been determined. Natural areas have been established in the Guanica, Maricao and Cambalache forests and in the Luquillo and Toro Negro Divisions of the Caribbean. Relatively undisturbed lower montane rain forest has been found to contain 40 to 50 species per acre. The dominant species, Dacryodes excelsa makes up 34% of the basal area. No other species makes up more than 6%.

Accomplishments During the Past Year: Project inactive.

Plans for Next Year: None

Date of Completion: Indefinite

Assignment: None

UTILIZATION OF PUERTO RICAN WOODS

Field Division: Forest Products

Work Project: Forest Utilization

Line Project: Forest Utilization

Purpose: To determine present and potential local requirements and uses for, and superficial properties of Puerto Rican woods.

Review of Past Work: Untreated Sloanea berteriana heartwood was found resistant to teredos 18 months in San Juan harbor. Fence posts of more common species normally last less than 2 years in service in more humid sections of Puerto Rico. Six-hour hot and cold bath carbolineum treatment of Casuarina equisetifolia caused lateral penetration of 3/4 to 2 inches. Hot and cold bath treatment of 3-inch posts of Didymopanax morototoni with carbolineum gave complete penetration after 2 hours of boiling. Preliminary study and report of wood utilization in Puerto Rico made by Teesdale and Girard for Puerto Rico Development Co. Approximate oven-dry specific gravities determined for 106 native and 3 exotic woods, with average found to be 0.70. Approximate green moisture content of sapwood of 28 native woods determined, and based on oven-dry weight, found to vary from 44 to 372 percent. Testing of 203 seasoned samples of 81 local woods showed equilibrium moisture content at Rio Piedras to be 14.6 percent. Two mangrove species, Avicennia nitida and Laguncularia racemosa, contained 19.0 and 18.3 percent respectively suggesting possibility that presence of salts in these woods may influence moisture content.

Accomplishments during Past Year: Received samples of more than 500 woods from Ecuador and Dutch Guiana.

Plans for Next Year: Routine reexamination of preservative tests in progress.

Date of Completion: Indefinite

Assignment: None

PUBLICATIONS AND PAPERS

García-Piquera, Carmen

A Spanish-English Glossary of Forestry Terminology.
Carib. For. 7:103-120.

Marrero, José

El Cultivo del Eucalypto en la Sierra de Ecuador. Carib. For.
7:57-69.

Upson, Arthur

Forests and Land Tenure in Puerto Rico.
Caribbean Land Symposium. Bulletin of Caribbean Commission,
Committee on Agriculture, Nutrition, Fisheries and Forestry
of the Caribbean Research Council, Washington DC., 1946. In
English with summaries in English, Spanish, French, and Dutch.
Pp. 233-244.

Statement of Policy and Objectives Governing the Forest Lands
of the People of Puerto Rico. Published (without authorship) in
Spanish in Ideología, Programas y Actividades, by Luis A. Izquierdo,
Commissioner of Agriculture and Commerce. Pp. 113-122. 1945.
(released in 1946).

The Mountain Area Defined, its Present and Possible Future Tenure
Relationships. Paper given at Conference on Problems of the
Mountain Area of Puerto Rico, June 6-8, 1946. (In Press).

Wadsworth, F.H.

La Influencia Climatológica e Hidrológica de los Bosques.
Revista de Agricultura (in press).